The use of Phylogenies for Conservation purposes

Arnica

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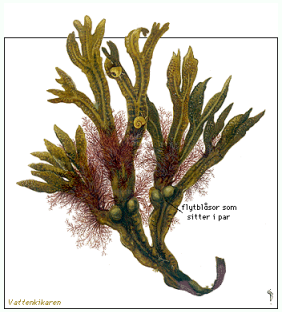
Overview

- Biological distinctivness
- Measures of diversity
- Example: Malvaceae
- *Arnica* evolution

Criteria for prioritizing threatened species

- Threat



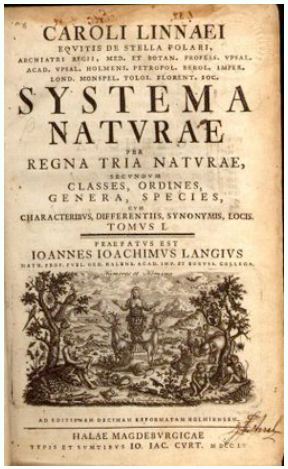
- Ecological importance
- Economical importance

- Charisma

→ • Biological distinctivness

Biological distinctiveness

- Traditional classifications



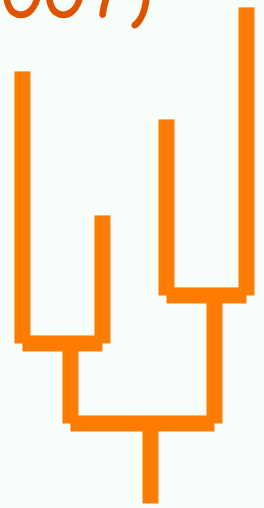
- Phylogenetic distinctness

  Tree based measures

Treebased diversity measures

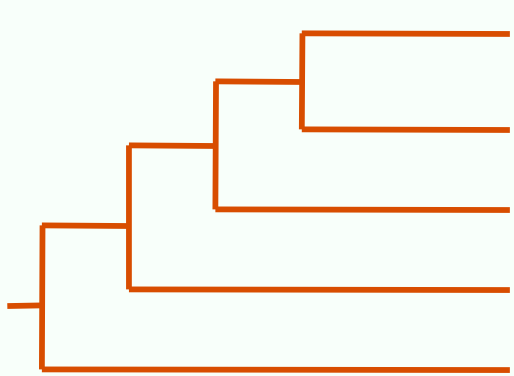
- **Topology based**
  - Taxonomic diversity (Vane-Wright & al 1991, Williams & al 1993)

- **Topology & branch lenghts**
  - Phylogenetic diversity PD (Faith 1992)
  - Evolutionary Distinctiveness ED (Isaac & al. 2007)
    - EDGE - includes extinction risk



Taxonomic diversity

- Topology based

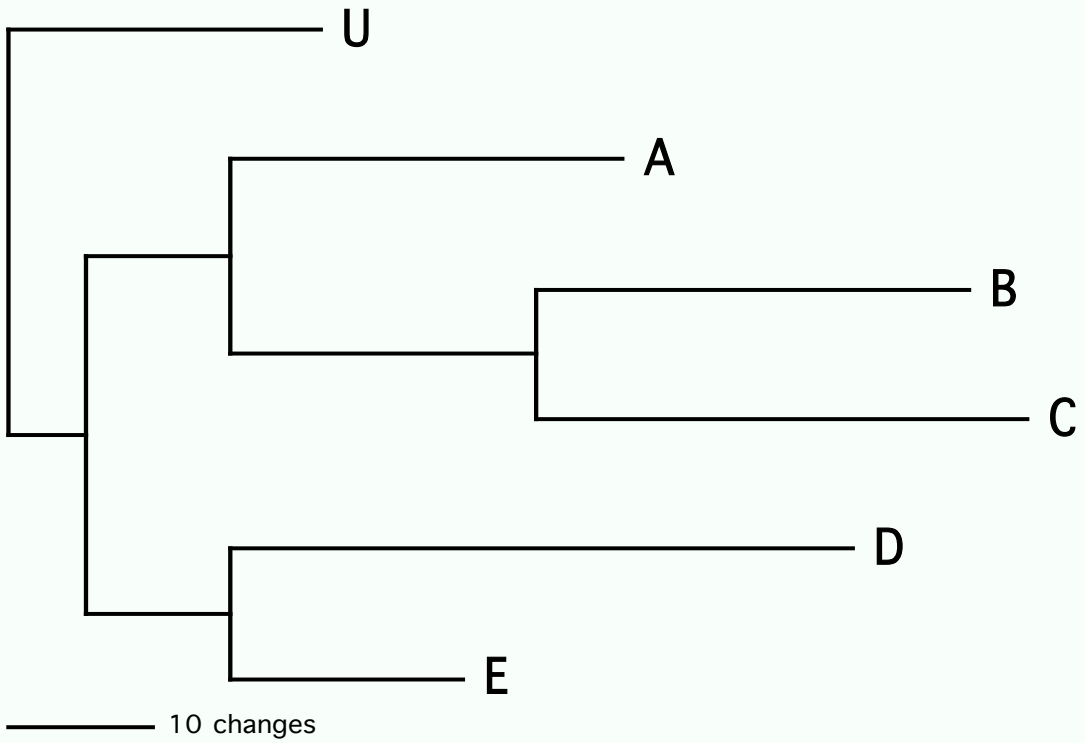


	#	T/#	V	%
A	4	3.5	1	10.7
B	4	3.5	1	10.7
C	3	4.7	1.3	14.3
D	2	7	2	21.4
E	1	14	4	42.9
Total	14	32.7	9.3	100

Vane-Wright & al. 1991

Phylogenetic diversity, PD

- Based on topology & branch lenghts

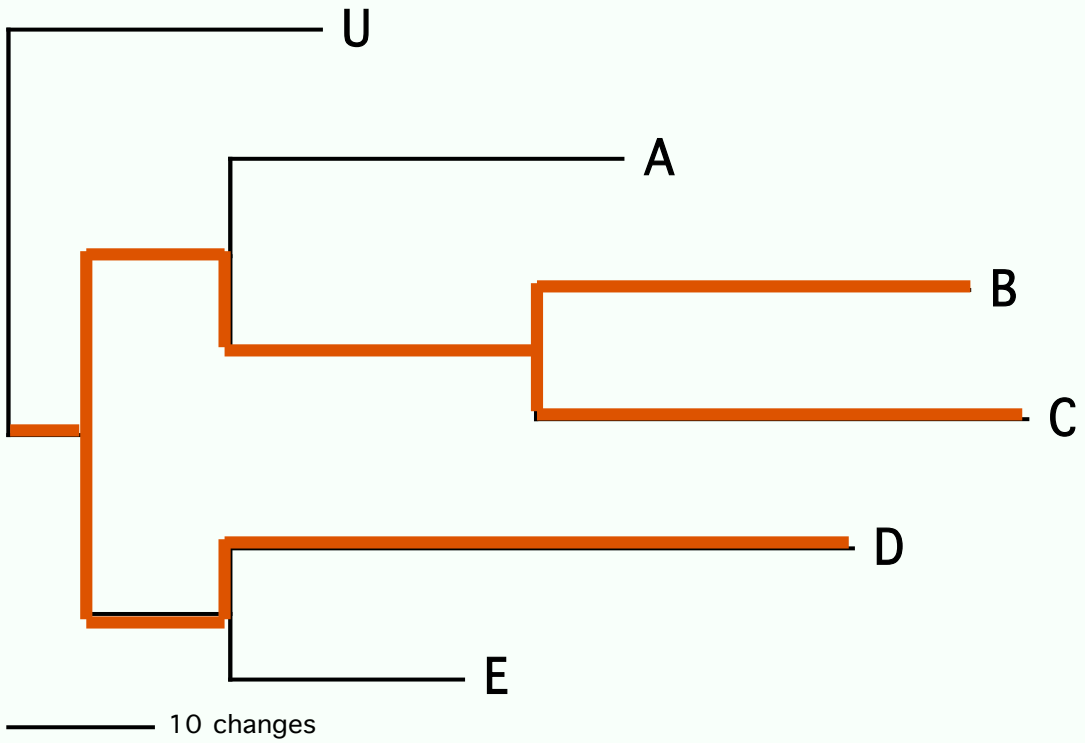


Faith 1992

Phylogenetic diversity, PD

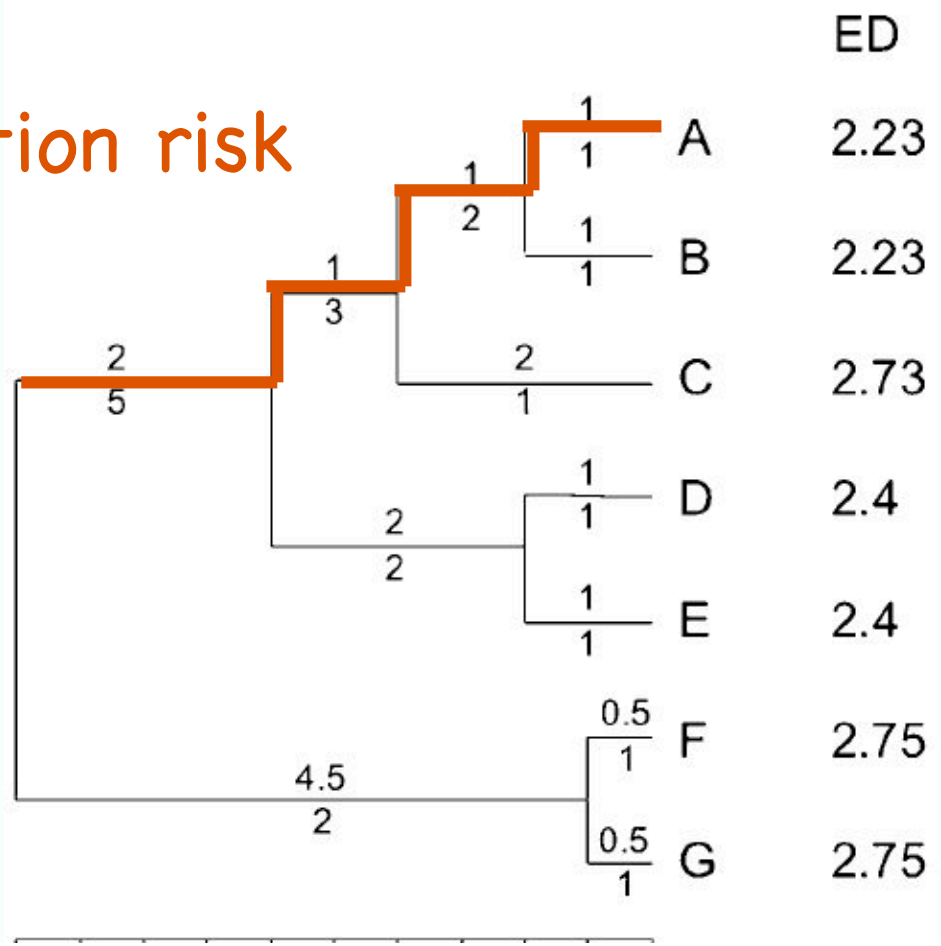
— = Minimum spaning path for B, C, D

PD for B, C, D : Σ lenghts of branches that are members of the minimum spaning path for B, C, D plus root



Evolutionary Distinctiveness, ED

- Species terminal branch & its species-weighted shares of ancestral branches
- EDGE includes extinction risk

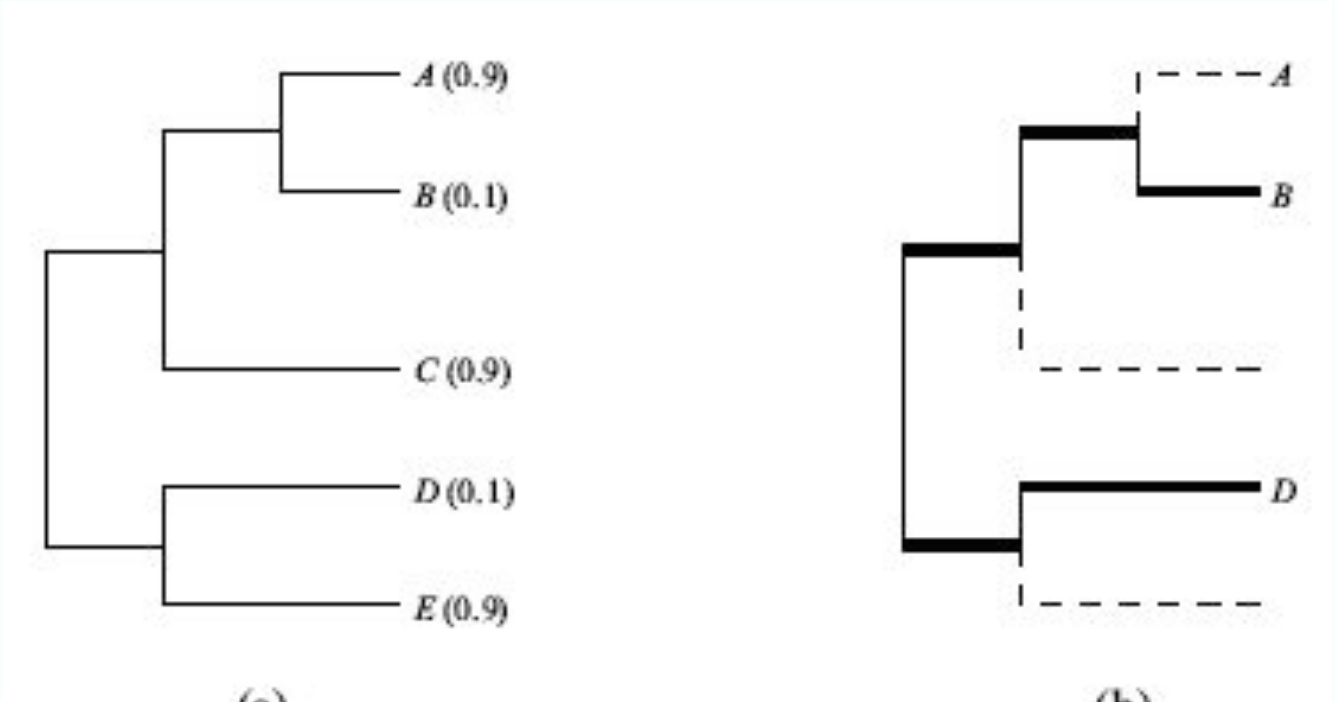


Isaac & al. 2007

Heightened Evolutionary Distinctiveness, HED

- Expected terminal branch lengths based on extinction probabilities (CR: 0.9 -> LC: 0.001)

- HEDGE weighted by current extinction risk



Steel & al. 2007

Prioritize between species based on PD

- Common species  represent assured PD
- Threatened species  have to be prioritized
- Priorities are based on the *gain* in PD by adding a threatened species, the *G-value*

PD for threatened taxa

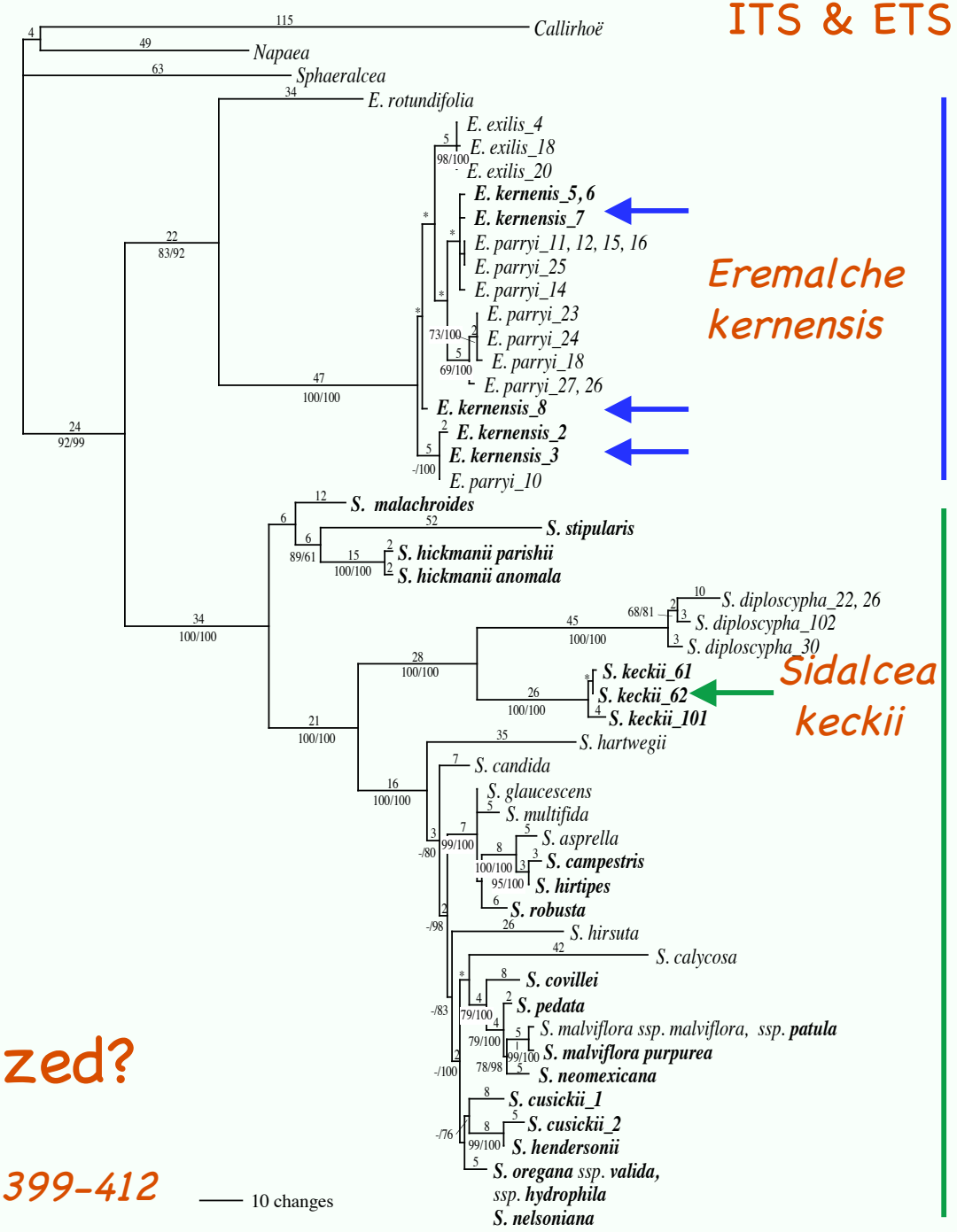
Two species pairs:
A common &
a threatened species

Malvaceae:
- *Eremalche*
- *Sidalcea*

Are the species distinct?
YES S. keckii
NO E. kernensis
How should they be prioritized?

Andreasen 2005. Conservation Genetics 6: 399-412

ITS & ETS



PD & G-values

Sidalcea stipularis

Lower G-value & Lower priority

Taxa	G-values/round									
	1	2	3	4	5	6	7	8	9	10
S. stipularis	**64**									
S. keckii #101	30	**30**								
S. cusickii	23		**23**							
S. hickmanii anomala	29	18		**17**						
S. hickmanii parishii	29	18		**17**						
S. malachroides	18[a]	12			**12**					
S. covillei	8					**8**				
S. robusta	6						**6**			
S. campestris	6						**6**			
S. oregana valida	6			5				**5**		
S. nelsoniana	6			5				**5**		
S. oregana hydrophila	6			5				**5**		
S. neomexicana	5							**5**		
S. keckii #61	28		2						**2**	
S. pedata	2								**2**	
E. kernensis #2	2								**2**	
S. malviflora purpurea	1									**1**
E. kernensis #5	1									**1**
E. kernensis #7	1									**1**

Programs for analyzing priorities

- Program Conserve 3.2.2
  (Agapow & Crozier 1998)
- Tuatara package of Mesquite
  (Maddison & Mooers 2007)
- MrTWIG
  (Wallberg)

Arnica: Hybridization, polyploidy & apomixis

Arnica angustifolia

- Hybridization hypotheses
- Di-,tri- & tetraploids X=19
- Polyploidy correlated to apomixis
- Correlation glaciated areas and polyploidy
- Polyploids more widespread than diploids

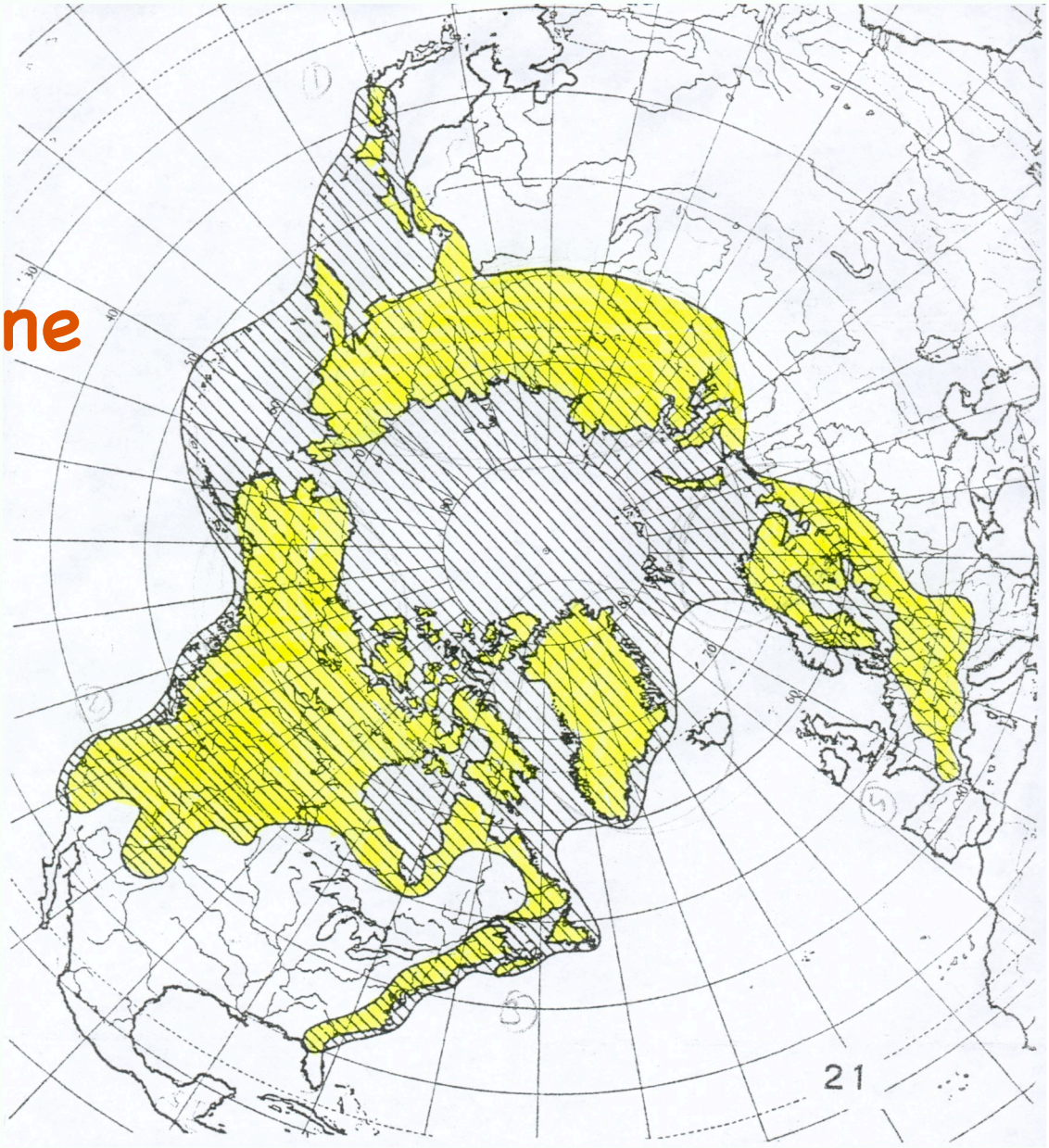
Biogeography

Circumboreal & montane

Widespread taxa

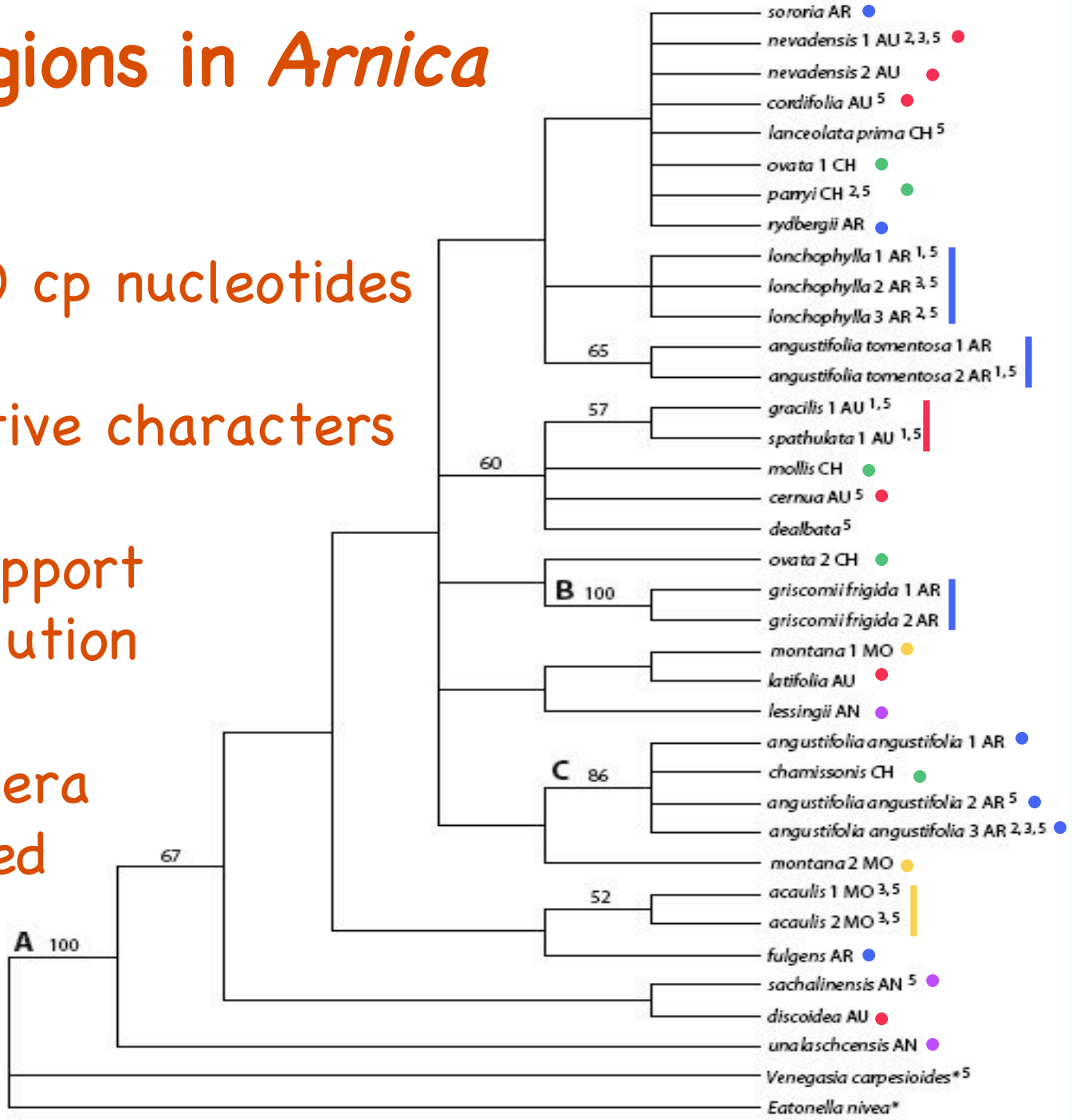
Disjunct taxa

World distribution of *Arnica*



Chloroplast regions in *Arnica*

- Sequenced >3700 cp nucleotides
- Only 45 informative characters
- Results in low support & low resolution
- Suggested subgenera are not supported

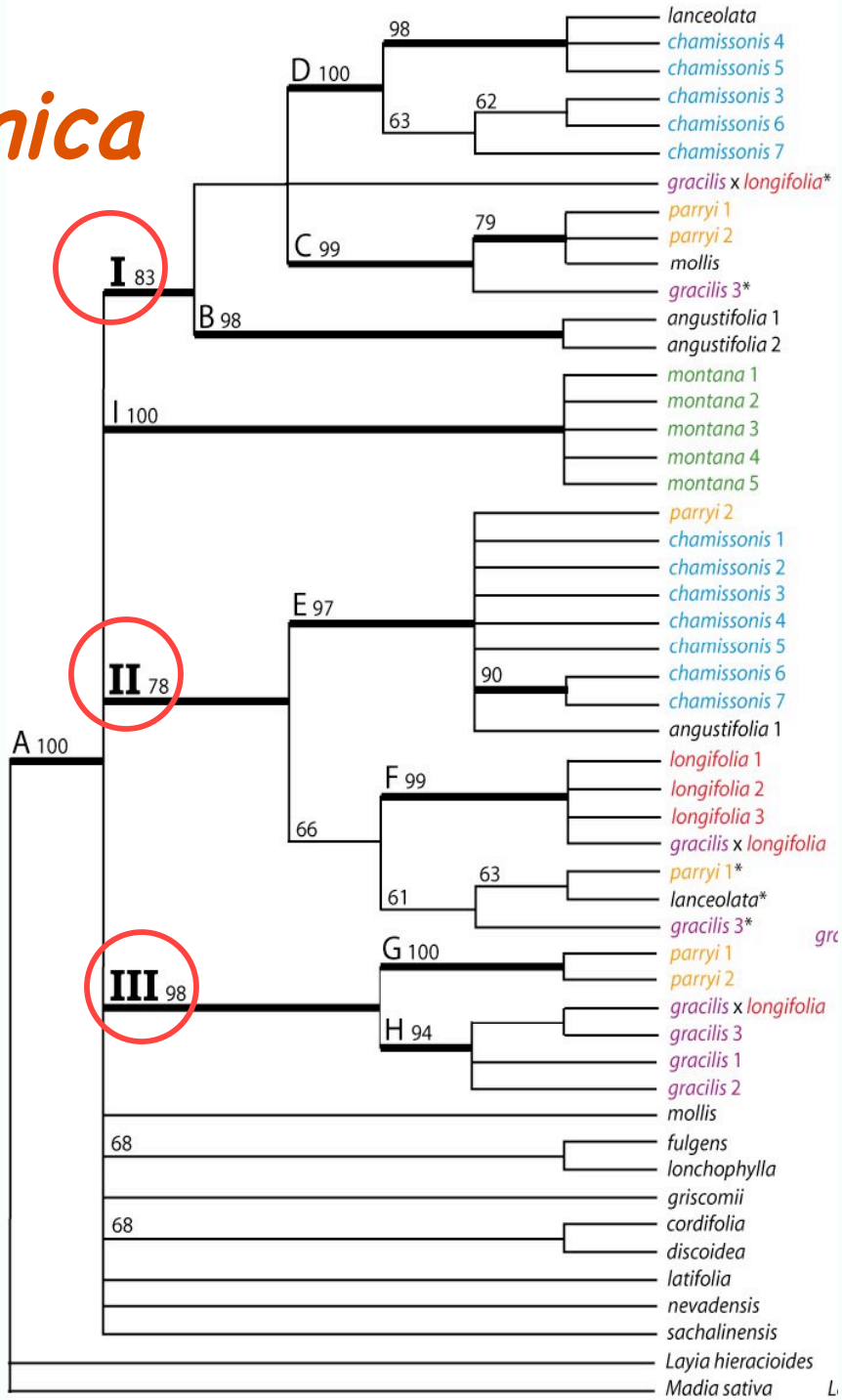


Ekenäs, Baldwin & Andreasen 2007.

Polymorphic nrDNA in *Arnica*

Agamospermy
(asexual seed production)

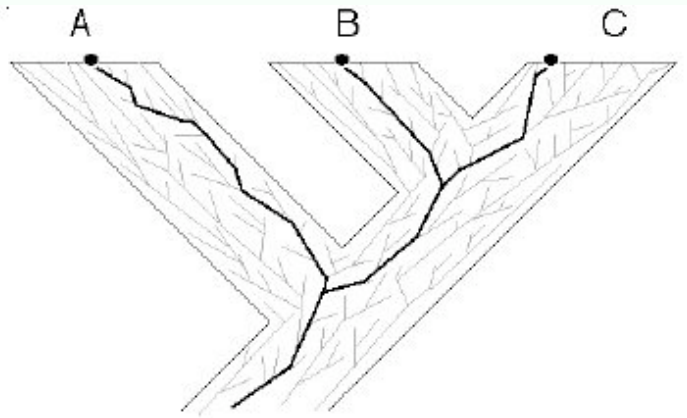
-> Incomplete
lineage sorting



Ekenäs et al. 2009

Lineage sorting:

the process of fixation of gene lineages along a species lineage

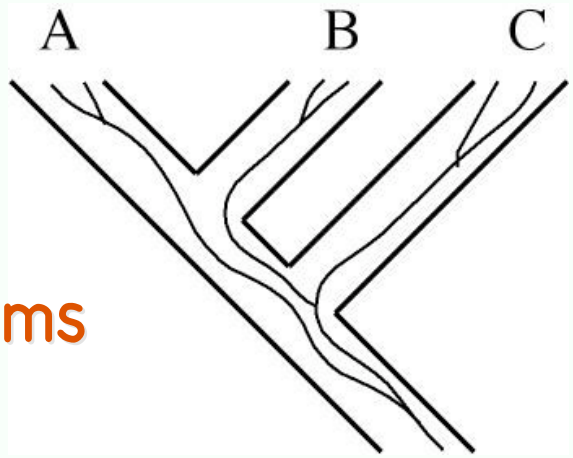


Incomplete lineage sorting:

Failure of allele fixation

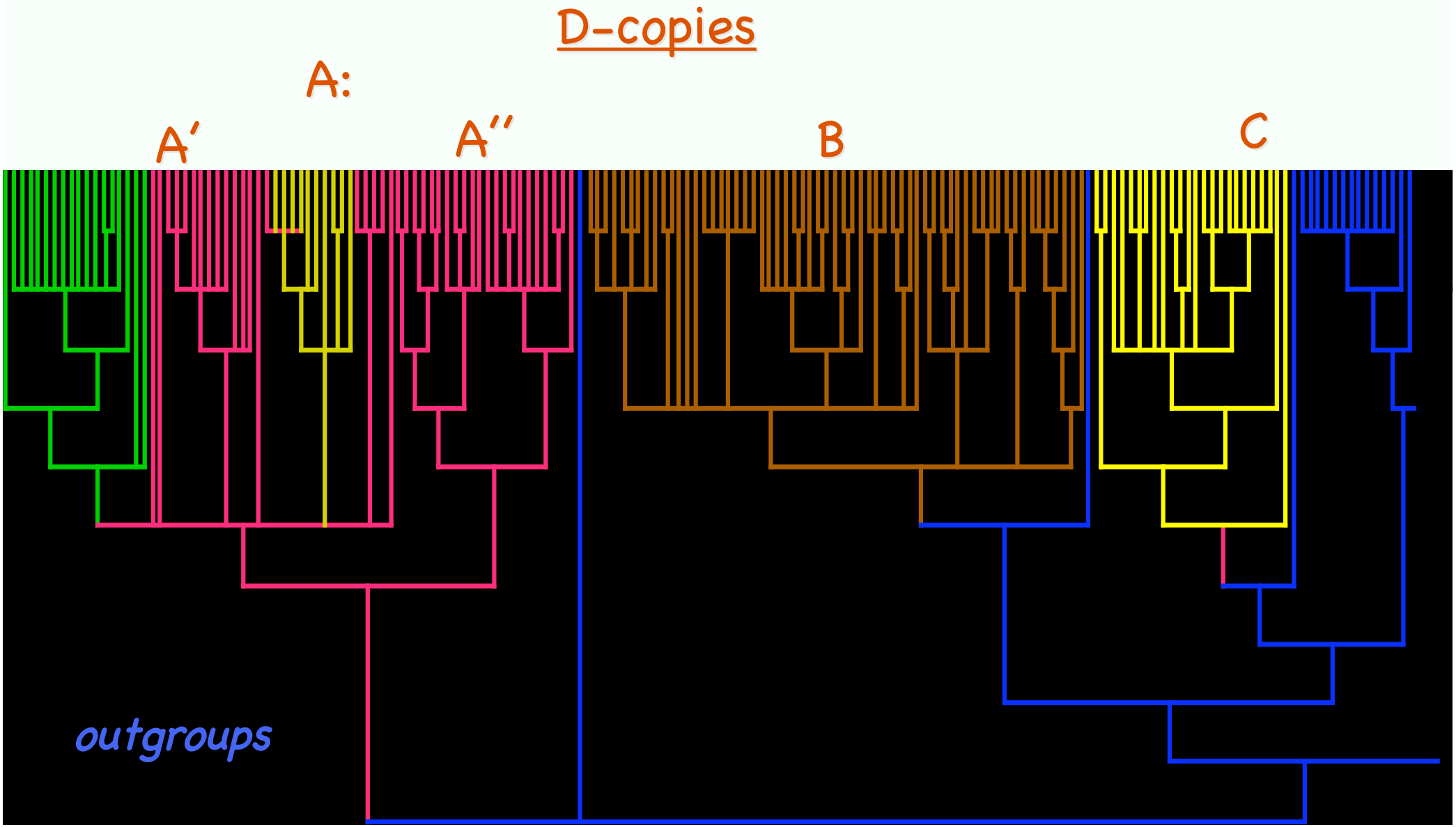
Retention of ancestral polymorphisms

Deep coalescence



More likely if time between divergences is short & population sizes large

RPB2-phylogeny in *Arnica*



Conclusions: *Arnica* evolution

- The 5 subgenera are not supported
- Results support a hypothesis of an origin in temperate western North America & subsequent dispersal to northern regions

- Polymorphisms in ribosomal DNA & low copy DNA may be caused by polyploidy, agamospermy, incomplete lineage sorting and hybridization
- The fact that the diploid species lack polymorphisms supports this

Collaborators & funding

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